

MULTIMEDIA



UNIVERSITY

STUDENT ID NO

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# MULTIMEDIA UNIVERSITY

## FINAL EXAMINATION

TRIMESTER 2, 2017/2018

**DCA5068 – FIELD THEORY**

(Diploma in Electronic Engineering)

9 MARCH 2018  
3:00 PM – 5:00 PM  
(2 Hours)

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### INSTRUCTIONS TO STUDENT

1. This question paper consists of 5 pages (4 pages with 4 questions and 1 page for appendix).
2. Answer ALL questions. All necessary working steps must be shown.
3. Write all your answers in the answer booklet provided.

**QUESTION 1 [25 Marks]**

- a) Two points are located in a free space. If the coordinates are measured in meter, find the distance from point A ( $r = 4.4$ ,  $\phi = -115^\circ$ ,  $z = 2$ ) to point B ( $x = -3.1$ ,  $y = 2.6$ ,  $z = -3$ ). [6 marks]
- b) In Cartesian coordinate system, vector  $\vec{A}$  is directed from point K = (2,7,-5) to point L = (-5,-5,-3) and vector  $\vec{B}$  is directed from point M = (0,2,4) to point N = (1,4,5). Find:
- i) Vector  $\vec{A}$ . [2 marks]
  - ii) Vector  $\vec{B}$ . [2 marks]
  - iii)  $\vec{A} \times \vec{B}$ . [3 marks]
  - iv)  $|\vec{A}|$  and  $|\vec{B}|$ . [2 marks]
  - v) The angle between  $\vec{A}$  and  $\vec{B}$ . [3 marks]
- c) Transform the following vector to cylindrical coordinate system at the specified point:

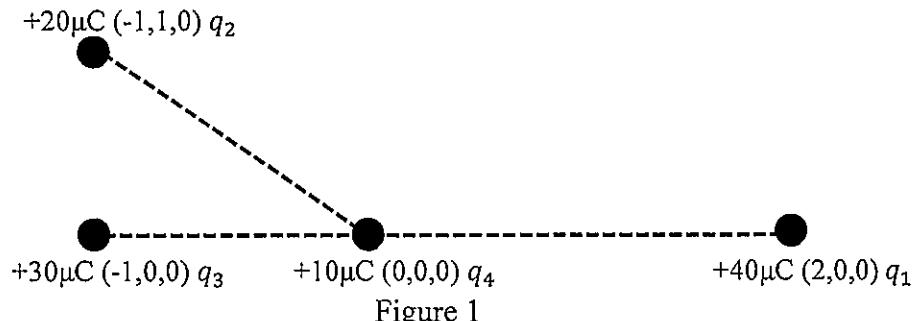
$$\vec{A} = 2\hat{i} + \hat{j} + \hat{k} \text{ at } P(x = 2, y = 3, z = 4)$$

[7 marks]

**Continued...**

**QUESTION 2 [25 Marks]**

- a) A charge  $Q_T$  is located at the origin and acts as a point charge to create an electric field between three other point charges of  $Q_1 = 20 \mu C$ ,  $Q_2 = 30 \mu C$  and  $Q_3 = 10 \mu C$  which are located at  $(3,0,5)$ ,  $(-2,0,3)$  and  $(2,0,1)$  respectively. Calculate the electric field strength at  $Q_T$ . [11 marks]
- b) By referring to Figure 1 below, calculate the total force,  $F_T$  on the point charge placed at the origin  $(0,0,0)$ .



[10 marks]

- c) Three capacitors with the value of  $10 \mu F$  each are being connected in parallel with a  $5 V$  voltage supply. Calculate:
- The total capacitance,  $C_T$  of the circuit. [2 marks]
  - The charge stored on each of the capacitor. [2 marks]

**Continued...**

**QUESTION 3 [25 Marks]**

- a) A single circular loop in the plane of the paper lies in a 0.90 T magnetic field pointing into the paper. If the loop's radius changes from 50 cm to 20 cm in 0.70 s, find:
- i) The direction of the induced current. [1 mark]
  - ii) The magnitude of the average induced EMF. [8 marks]
  - iii) The average induced current if the coil resistance is 15  $\Omega$ . [2 marks]
- b) Calculate the magnitude of the induced EMF in the loop, when 7 Wb/m<sup>2</sup> magnetic fields is directed perpendicular to the plane of a 150 turns loop, which has a diameter of 0.2 m. The loop is rotated through the 145° in 0.30 s. [6 marks]
- c) According to Faraday's law of induction, what are the factors that affect the magnitude of the induced current? [3 marks]
- d) How to calculate a magnetic field across any closed loop path? Justify your answer. [2 marks]
- e) If a bar magnet is being inserted into a coil of wire that conducts electricity, what is the direction of an induced current? Justify your answer. [3 marks]

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**Continued...**

**QUESTION 4 [25 Marks]**

- a) Define Magnetomotive Force (MMF). [3 marks]
- b) State three differences between magnetic circuit and electric circuit. [6 marks]
- c) Briefly explain about Eddy currents. [6 marks]
- d) A transformer has a 1:10 voltage ratio. Find the current flow in the secondary winding if the current flow in the primary winding is equal to 60 mA. [3 marks]
- e) Given that the power delivered by the secondary winding is  $P_{sec} = 10W$ . What is the value of the power delivered by the primary winding  $P_{pri}$  in an ideal transformer? [2 marks]
- f) In an ideal transformer configuration, prove the following formula:

$$I_{sec} = \left[ \frac{1}{n} \right] I_{pri}$$

[5 marks]

**End of Page.**

FORMULAE

Transformation	Coordinate Variables	Unit Vectors	Vector Components
Cartesian to Cylindrical	$r = \sqrt{x^2 + y^2}$ $\phi = \tan^{-1}(y/x)$ $z = z$	$\hat{r} = \hat{x} \cos \phi + \hat{y} \sin \phi$ $\hat{\phi} = -\hat{x} \sin \phi + \hat{y} \cos \phi$ $\hat{z} = \hat{z}$	$A_r = A_x \cos \phi + A_y \sin \phi$ $A_\phi = -A_x \sin \phi + A_y \cos \phi$ $A_z = A_z$
Cylindrical to Cartesian	$x = r \cos \phi$ $y = r \sin \phi$ $z = z$	$\hat{x} = \hat{r} \cos \phi - \hat{\phi} \sin \phi$ $\hat{y} = \hat{r} \sin \phi + \hat{\phi} \cos \phi$ $\hat{z} = \hat{z}$	$A_x = A_r \cos \phi - A_\phi \sin \phi$ $A_y = A_r \sin \phi + A_\phi \cos \phi$ $A_z = A_z$
Cartesian to Spherical	$R = \sqrt{x^2 + y^2 + z^2}$ $\theta = \tan^{-1}(\sqrt{x^2 + y^2} / z)$ $\phi = \tan^{-1}(y/x)$	$\hat{R} = \hat{x} \sin \theta \cos \phi + \hat{y} \sin \theta \sin \phi + \hat{z} \cos \theta$ $\hat{\theta} = \hat{x} \cos \theta \cos \phi + \hat{y} \cos \theta \sin \phi - \hat{z} \sin \theta$ $\hat{\phi} = -\hat{x} \sin \phi + \hat{y} \cos \phi$	$A_R = A_x \sin \theta \cos \phi + A_y \sin \theta \sin \phi + A_z \cos \theta$ $A_\theta = A_x \cos \theta \cos \phi + A_y \cos \theta \sin \phi - A_z \sin \theta$ $A_\phi = -A_x \sin \phi + A_y \cos \phi$
Spherical to Cartesian	$x = R \sin \theta \cos \phi$ $y = R \sin \theta \sin \phi$ $z = R \cos \theta$	$\hat{x} = \hat{R} \sin \theta \cos \phi + \hat{\theta} \cos \theta \cos \phi - \hat{\phi} \sin \phi$ $\hat{y} = \hat{R} \sin \theta \sin \phi + \hat{\theta} \cos \theta \sin \phi + \hat{\phi} \cos \phi$ $\hat{z} = \hat{R} \cos \theta - \hat{\theta} \sin \theta$	$A_x = A_R \sin \theta \cos \phi + A_\theta \cos \theta \cos \phi - A_\phi \sin \phi$ $A_y = A_R \sin \theta \sin \phi + A_\theta \cos \theta \sin \phi + A_\phi \cos \phi$ $A_z = A_R \cos \theta - A_\theta \sin \theta$
Cylindrical to Spherical	$R = \sqrt{r^2 + z^2}$ $\theta = \tan^{-1}(r/z)$ $\phi = \phi$	$\hat{R} = \hat{r} \sin \theta + \hat{z} \cos \theta$ $\hat{\theta} = \hat{r} \cos \theta - \hat{z} \sin \theta$ $\hat{\phi} = \hat{\phi}$	$A_R = A_r \sin \theta + A_z \cos \theta$ $A_\theta = A_r \cos \theta - A_z \sin \theta$ $A_\phi = A_\phi$
Spherical to Cylindrical	$r = R \sin \theta$ $\phi = \phi$ $z = R \cos \theta$	$\hat{r} = \hat{R} \sin \theta + \hat{\theta} \cos \theta$ $\hat{\phi} = \hat{\phi}$ $\hat{z} = \hat{R} \cos \theta - \hat{\theta} \sin \theta$	$A_r = A_R \sin \theta + A_\theta \cos \theta$ $A_\phi = A_\phi$ $A_z = A_R \cos \theta - A_\theta \sin \theta$

Permittivity of free space,  $\epsilon_0 = 8.854 \times 10^{-12} F/m$

Permeability of free space,  $\mu_0 = 4\pi \times 10^{-7} T.m/A$